APPENDIX I

GLOSSARY

ABSOLUTE INSTABILITY.—The state of a column of air in the atmosphere when it has a superadiabatic lapse rate of temperature. An air parcel displaced vertically would be accelerated in the direction of the displacement.

ABSOLUTE STABILITY.—The state of a column of air in the atmosphere when its lapse rate of temperature is less than the saturation adiabatic lapse rate. An air parcel will be more dense than its environment and tend to sink back to its level of origin.

ABSOLUTE VORTICITY.—The vorticity of a fluid particle determined by taking into account Earth's movement.

ABSORPTION.—The process in which incident radiant energy is retained by a substance.

ADVECTION.—The horizontal transport of an atmospheric property solely by the mass motion (velocity field) of the atmosphere.

ADVECTION FOG.—Fog caused by the advection of moist air over a cold surface, and the consequent cooling of that air to below its dew point.

AIR MASS.—A widespread body of air that is approximately homogeneous in its horizontal extent, with reference to temperature and moisture.

ALBEDO.—The ratio of the amount of electromagnetic radiation reflected by a body to the amount incident upon it.

ANABATIC WIND.—An upslope wind; usually applied only when the wind is blowing up a hill or mountain as the result of surface heating.

ANTARCTIC FRONT.—The semipermanent, semicontinuous front between the antarctic air of the Antarctic Continent and the polar air of the southern oceans; generally comparable to the arctic front of the Northern Hemisphere.

ANTICYCLOGENESIS.—The strengthening or development of an anticyclonic circulation in the atmosphere.

ANTICYCLOLYSIS.—The weakening of an anticyclonic circulation in the atmosphere.

ANTICYCLONE.—A closed circulation in the atmosphere that has a clockwise rotation in the Northern Hemisphere and a counterclockwise rotation in the Southern Hemisphere. Used interchangeably with *high*.

ANTICYCLONIC.—Refers to the rotation pattern of anticyclones. See ANTICYCLONE.

ARCTIC FRONT.—The semipermanent, semicontinuous front between the deep, cold arctic air and the shallower, basically-less-cold polar air of northern latitudes; generally comparable to the antarctic front of the Southern Hemisphere.

AUTOCONVECTIVE LAPSE RATE.—The temperature lapse rate in an atmosphere where density is constant with height.

BACKING.—A change in wind direction in a counterclockwise manner in the Northern Hemisphere and a clockwise manner in the Southern Hemisphere.

BLOCKING HIGH.—An anticyclone that remains stationary or moves slowly westward so as to effectively block the movement of migratory cyclones across its latitudes.

BRIGHT BAND.—As seen on a range-height indicator, the enhanced radar echo of snow as it melts to rain. The freezing level can normally be found approximately 1,000 feet above this band.

BUYS BALLOT'S LAW.—The law describing the relationship of horizontal wind direction to pressure: In the Northern Hemisphere, with your back to the wind, the lowest pressure will be to your left; in the Southern Hemisphere, the reverse is true.

CENTER OF ACTION.—Any one of the semipermanent high- or low-pressure systems.

CENTRAL PRESSURE.—The atmospheric pressure at the center of a high or low; the highest pressure in a high, the lowest in a low.

CHROMOSPHERE.—A thin layer of relatively transparent gases above the photosphere of the Sun.

CLOSED HIGH.—A high that is completely encircled by an isobar or contour line.

CLOSED LOW.—A low that is completely encircled by an isobar or contour line.

COLD-CORE HIGH.—Any high that is generally characterized by colder air near its center than around its periphery at a given level in the atmosphere.

COLD-CORE LOW.—Any low that is generally characterized by colder air near its center than around its periphery at a given level in the atmosphere.

CONDENSATION.—The physical process by which a vapor becomes a liquid or solid.

CONDITIONAL INSTABILITY.—The state of a column of air in the atmosphere when its temperature lapse rate is less than the dry adiabatic lapse rate but greater than the saturation adiabatic lapse rate.

CONTOURS.—Term referring to constant height lines on a constant-pressure chart. Used interchangeably with *isoheights*. Each line represents a line of constant elevation above a certain reference level (usually mean sea level).

CONVECTION.—Atmospheric motions that are predominantly vertical, resulting in the vertical transport and mixing of atmospheric properties.

CORONA.—(1) A set of one or more prismatically colored rings of small radii, concentrically surrounding the disk of the Sun, Moon, or other luminary when veiled by a thin cloud. A corona maybe distinguished from the relatively common 22° halo by its color sequence, which is from blue inside to red outside, the reverse of that of the 22° halo. Coronas are produced by diffraction and reflection of light from water droplets. (2) The pearly outer envelope of the Sun.

COUNTERRADIATION.—(also called back radiation) The downward flow of atmospheric radiation passing through a given level surface, usually taken as Earth’s surface. It is the principal factor in the GREENHOUSE EFFECT.

CUT-OFF HIGH.—A warm high displaced and lying poleward of the basic westerly current.

CUT-OFF LOW.—A cold low displaced and lying equatorward of the basic westerly current.

CYCLOGENESIS.—Any development or strengthening of cyclonic circulation in the atmosphere. The initial appearance of a low or trough, as well as the intensification of an existing cyclonic flow.

CYCLOLYSIS.—Any weakening of cyclonic circulation in the atmosphere.

CYCLONIC.—A counterclockwise rotation in the Northern Hemisphere and a clockwise rotation in the Southern Hemisphere.

DEEPENING.—A decrease in the central pressure of a low-pressure system.

DISPERSION.—The process in which radiation is separated into its component wavelengths. It results when an optical process, such as diffraction, refraction, or scattering, varies according to wavelength. All of the coloration displayed by atmospheric optical phenomena is the result of dispersion.

DOLDRUMS.—A nautical term for the equatorial trough, with special reference to the light and variable nature of the winds.

DOWNWIND.—The direction toward which the wind is blowing; with the wind.

DROPSONDE.—A radiosonde that is dropped by parachute from an aircraft for the purpose of obtaining a sounding of the atmosphere below.

DRY AIR.—In atmospheric thermodynamics and chemistry, air that contains no water vapor.

DYNAMIC TROUGH.—(also called lee trough) A pressure trough formed on the lee side of a mountain range across which the wind is blowing almost at right angles; often seen, on U.S. weather maps, east of the Rocky Mountains, and sometimes east of the Appalachians, where it is less pronounced.

EASTERLIES.—Any winds with components from the east, usually applied to broad currents or patterns of persistent easterly winds; the "easterly belts," such as the equatorial easterlies, the tropical easterlies (trade winds), and the polar easterlies.

EASTERLY WAVE.—A migratory wave-like disturbance of the tropical easterlies. Easterly waves occasionally intensify into tropical cyclones.

ELECTROMAGNETIC WAVES.—Disturbances in electric and magnetic fields in space or in material media, resulting in the propagation of electromagnetic energy (radiation).

EQUATORIAL TROUGH.—The quasi-continuous belt of low pressure lying between the subtropical high-pressure belts of the Northern and Southern hemispheres. The region is one of very homogeneous air, probably the most ideally barotropic region of the atmosphere. The position of the equatorial trough is fairly constant in the eastern portions of the Atlantic and Pacific, but it varies greatly in the western portions of those oceans and in southern Asia and the Indian Ocean. It moves into or toward the hemisphere experiencing summer.

EQUINOX.—(1) Either of the two points of intersection of the Sun's apparent annual path and the plane of Earth's equator. (2) Popularly, the time at which the Sun passes directly above the equator; the "time of the equinox." In the Northern Hemisphere, the vernal equinox falls on or about 21 March, and the autumnal equinox on or about 22 September. These dates are reversed in the Southern Hemisphere.

EVAPORATION.—The physical process by which a liquid or solid is transformed to the gaseous state.

EXTRATROPICAL CYCLONE.—Typically, any cyclonic-scale storm that forms poleward of the tropical easterlies, i.e., the migratory frontal cyclones. Tropical cyclones that move poleward out of the tropical easterlies and take on extratropical characteristics (air mass discontinuity) are reclassified as extratropical.

FILLING.—An increase in the central pressure of a pressure system on a constant-height chart, or an analogous increase in height on a constant-pressure chart; the opposite of *deepening.*

FRONT.—The interface or transition zone between two air masses of different density. Since temperature distribution is the most important regulator of atmospheric density, a front almost invariably separates air masses of different temperature.

FRONTAL INVERSION.—A temperature inversion in the atmosphere, encountered upon vertical ascent through a sloping front.

FRONTAL SURFACE.—Refers specifically to the warmer side of the frontal zone.

FRONTAL SYSTEM.—Simply, a system of fronts as they appear on a synoptic chart. This is used for (a) a continuous front and its characteristics along its entire extent, including its warm, cold, stationary, and occluded sectors, its variations of intensity, and any frontal cyclones along it; and (b) the orientation and nature of the fronts within the circulation of a frontal cyclone.

FRONTAL ZONE.—The transition zone between two adjacent air masses of different densities bounded by a frontal surface.

FRONTOGENESIS.—The initial formation of a front or frontal zone.

FRONTOLYSIS.—The dissipation of a front or frontal zone.

GENERAL CIRCULATION.—(also called planetary circulation) In its broadest sense, the complete statistical description of atmospheric motions over Earth.

GEOPOTENTIAL.—The potential energy of a unit mass relative to sea level, numerically equal to the work that would be done in lifting the unit mass from sea level to the height at which the mass is located; commonly expressed in terms of *dynamic height* or *geopotential height.*

GEOPOTENTIAL HEIGHT.—The height of a given point in the atmosphere in units proportional to the potential energy of a unit mass (geopotential) at that height, relative to sea level.

GEOSTROPHIC FLOW.—A form of gradient flow where the Coriolis force exactly balances the horizontal pressure force.

GEOSTROPHIC WIND.—That horizontal wind velocity for which the Coriolis acceleration exactly balances the horizontal pressure force. The geostrophic wind is directed along the contour lines on a constant-pressure surface (or along the isobars in a geopotential surface) with low pressure to the left in the Northern Hemisphere and to the right in the Southern Hemisphere.

GEOSTROPHIC-WIND SCALE.—A graphical device used for the determination of the speed of the geostrophic wind from the isobar or contour-line spacing on a synoptic chart.

GRADIENT.—The space rate of decrease of a function. It is often used to denote the magnitude of pressure change in the horizontal pressure field.

GRADIENT WIND.—Any horizontal wind velocity tangent to the contour line of a constant-pressure surface (or the isobar of a geopotential surface) at the point in question. At such points, where the wind is gradient, the Coriolis acceleration and centripetal acceleration together exactly balance the horizontal pressure force.

GRAVITY WIND.—(also called drainage wind; sometimes called katabatic wind) A wind (or component thereof) directed down the slope of an incline and caused by greater air density near the slope (caused by surface cooling) than at the same levels some distance horizontally from the slope.

GREENHOUSE EFFECT.—The heating effect exerted by the atmosphere upon Earth by virtue of the fact that the atmosphere (mainly, its water vapor) absorbs and re-emits infrared radiation. In detail: The shorter wavelengths of insolation are transmitted rather freely through the atmosphere to be absorbed at Earth's surface. Earth then re-emits this as long-wave (infrared) terrestrial radiation, a portion of which is absorbed by the atmosphere and again emitted as atmospheric radiation. The water vapor (cloud cover) acts in the same way as the glass panes of a greenhouse; the heat gained during the day is trapped beneath the cloud cover, and the counter-radiation adds to the warming of Earth.

GROUND CLUTTER.—The pattern of radar echoes from fixed ground targets near the radar. This type of clutter tends to hide or confuse the echoes returned from nearby moving or precipitation targets. Ground clutter can be significantly increased during periods of superrefraction.

HALO.—Any one of a large class of atmospheric optical phenomena (luminous meteors) that appear as colored or whitish rings and arcs about the Sun or Moon when seen through an ice crystal cloud or in a sky filled with falling ice crystals. The halos experiencing prismatic coloration are produced by refraction of light by the ice crystals, and those exhibiting only whitish luminosity are produced by reflection from the crystal faces.

HEAT BALANCE.—The equilibrium, which exists on the average, between the radiation received by Earth and its atmosphere and that emitted by Earth and its atmosphere.

HEATING DEGREE-DAY.—A form of degree day used as an indication of fuel consumption; in United States usage, one heating degree-day is given for each degree that the daily mean temperature departs below the base of 65°F.

HEAT TRANSFER.—The transfer or exchange of heat by radiation, conduction, or convection in a fluid and/or between the fluid and its surroundings. The three processes occur simultaneously in the atmosphere, and it is often difficult to assess the contributions of their various effects.

HIGH.—An "area of high pressure," referring to a maximum of atmospheric pressure in two dimensions (closed isobars) on the synoptic surface chart, or a maximum of height (closed contours) on the constant-pressure chart. Highs are associated with anticyclonic circulations, and the term is used interchangeably with anticyclone.

HIGH ZONAL INDEX.—A relatively high value of the zonal index which, in middle latitudes, indicates a relatively strong westerly component of wind flow and the characteristic weather features attending such motion. A synoptic circulation pattern of this type is commonly called a “high-index situation.”

HORSE LATITUDES.—The belts of latitude over the oceans at approximately 30 to 35 degrees north and south where winds are predominantly calm or very light and the weather is hot and dry.

HURRICANE.—A severe tropical cyclone in the North Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and in the eastern North Pacific, off the west coast of Mexico.

ICELANDIC LOW.—The low-pressure center located near Iceland (mainly between Iceland and southern Greenland) on mean charts of sea-level pressure. It is a principal center of action in the atmospheric circulation of the Northern Hemisphere.

INACTIVE FRONT.—(or passive front) A front or portion thereof that produces very little cloudiness and no precipitation, as opposed to an active front.

INFERIOR MIRAGE.—A spurious image of an object formed below the true position of that object by abnormal refractive conditions along the line of sight; one of the most common of all types of mirage, and the opposite of a superior mirage.

INFRARED RADIATION.—Electromagnetic radiation lying in the wavelength interval from about 0.8 micron to an indefinite upper boundary, sometimes arbitrarily set at 1,000 microns. On the lower side of the electromagnetic spectrum, it is bounded by visible radiation, while on the upper side it is bounded by microwave radiation.

INSOLATION.—(contracted from *incoming solar radiation)* In general, solar radiation received at Earth’s surface.

INSTABILITY.—A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude.

INSTABILITY LINE.—Any non-frontal line or band of convective activity in the atmosphere.

INTERTROPICAL CONVERGENCE ZONE.—The axis or a portion thereof, of the broad trade-wind current of the tropics. This axis is the dividing line between the southeast trades and the northeast trades (of the Southern and Northern hemispheres, respectively).

INTERTROPICAL FRONT.—A front presumed to exist within the equatorial trough separating the air of the Northern and Southern hemispheres. However, this front cannot be explained in the same terms as the fronts of higher latitudes.

INVERSION.—The departure from the usual decrease or increase with altitude of the value of an atmospheric property. The layer through which this departure occurs is known as the inversion layer, and the lowest altitude at which the departure is found is known as the base of the inversion. The term is almost always used in reference to temperature, but may be applied to moisture and precipitation.

ISALLOBAR.—A line of equal change in atmospheric pressure during a specified time interval; an isopleth of equal pressure tendency. Positive and negative isallobars are sometimes referred to as anallobars and katallobars, respectively.

ISOBAR.—A line of equal or constant pressure; an isopleth of pressure.

ISOBARIC.—Of equal or constant pressure, with respect to either space or time.

ISODROSOTHERM.—A line of equal dew point temperatures.

ISOHEIGHT.—See CONTOUR.

ISOHYET.—A line drawn through geographical points recording equal amounts of precipitation during a given period or for a particular storm. A line of equal precipitation.

ISOPLETH.—A line of equal or constant value of a given quantity, with respect to either space or time.

ISOPYCNIC LEVEL. —Specifically, a level surface in the atmosphere, at about an 8-km altitude, where the air density is approximately constant in space and time.

ISOTACH.—A line in a given surface connecting points of equal wind speed.

ISOTHERM.—A line of equal or constant temperature.

ISOTHERMAL.—Of equal or constant temperature, with respect to either space or time.

JET.—A common contraction for jet stream.

JET STREAM.—Relatively strong winds concentrated within a narrow quasi-horizontal stream in the atmosphere. These winds are usually embedded in the midlatitude westerlies and concentrated in the high troposphere.

KATABATIC WIND.—Any wind blowing down an incline; the opposite of anabatic wind. If the wind is warm, it is called a foehn; if cold, it may be a fall or gravity wind.

KINETIC ENERGY.—The energy that a body possesses as a consequence of its motion, defined as the product of one-half of its mass and the square of its speed, 1/2mv squared.

LAND BREEZE.—A coastal breeze blowing from land to sea, caused by the temperature difference when the sea surface is warmer than the adjacent land.

LAPSE RATE.—The decrease of an atmospheric variable with height, the variable being temperature unless otherwise specified.

LATERAL MIRAGE.—A very rare type of mirage in which the apparent position of an object appears displaced to one side of its true position.

LIGHT.—Visible radiation (about 0.4 to 0.7 micron in wavelength) considered in terms of its luminous efficiency.

LONG WAVE.—A wave in the major belt of westerlies that is characterized by large length and significant amplitude. The wavelength is typically longer than that of the rapidly moving individual cyclonic and anticyclonic disturbances of the lower troposphere. (Compare SHORT WAVE.)

LOOMING.—A mirage effect produced by greater-than-normal refraction in the lower atmosphere, thus permitting objects to be seen that are usually below the horizon.

LOW.—An "area of low pressure," referring to a minimum of atmospheric pressure in two dimensions (closed isobars) on a constant-height chart or a minimum of height (closed contours) on a constant-pressure chart. Lows are associated with cyclonic circulations, and the term is used interchangeably with *cyclone.*

LOWER ATMOSPHERE.—Generally and quite loosely, that part of the atmosphere in which most weather phenomena occur (i.e., the troposphere and lower stratosphere).

LOW ZONAL INDEX.—A relatively low value of the zonal index, which in middle latitudes indicates a relatively weak westerly component of wind flow (usually implying stronger north-south motion), and the characteristic weather attending such motion. A circulation pattern of this type is commonly called a "low-index situation."

MACROCLIMATE.—The general large-scale climate of a large area or country, as distinguished from the mesoclimate and microclimate.

MAGNETIC NORTH.—At any point on Earth's surface, the horizontal direction of the Earth's magnetic lines of force (direction of a magnetic meridian) toward the north magnetic pole, i.e., a direction indicated by the needle of a magnetic compass. Because of the wide use of the magnetic compass, magnetic north, rather than TRUE NORTH, is the common 0° (or 360°) reference in much of navigational practice, including the designation of airport runway alignment.

MANDATORY LEVEL.—One of several constant-pressure levels in the atmosphere for which a complete evaluation of data derived from upper-air observations is required. Currently, the mandatory pressure values are 1,000 mb, 850 mb, 700 mb, 500 mb, 400 mb, 300 mb, 200 mb, 150 mb, 100 mb, and 50 mb. The radiosonde code has specific blocks reserved for these data.

MARITIME AIR.—A type of air whose characteristics are developed over an extensive water surface and which, therefore, has the basic maritime quality of high moisture content in at least its lower levels.

MEAN SEA LEVEL.—The average height of the sea surface, based upon hourly observation of tide height on the open coast or in adjacent waters which have free access to the sea. In the United States, mean sea level is defined as the average height of the surface of the sea for all stages of the tide over a 19-year period.

MERIDIONAL FLOW.—A type of atmospheric circulation pattern in which the meridional (north and south) component of motion is unusually pronounced. The accompanying zonal component is usually weaker than normal.

MESOCLIMATE.—The climate of small areas of Earth's surface that may not be representative of the general climate of the district. The places considered in mesoclimatology include small valleys, "frost hollows," forest clearings, and open spaces in towns, all of which may have extremes of temperature differing by many degrees from those of adjacent areas. The mesoclimate is intermediate in scale between the microclimate and microclimate.

MESOPAUSE.—The top of the mesosphere. This corresponds to the level of minimum temperature at 70 to 80 km.

MESOSPHERE.—The atmospheric shell between about 20 km and about 70 or 80 km, extending from the top of the stratosphere to the upper temperature minimum (the menopause). It is characterized by a broad temperature maximum at about 50 km, except possibly over the winter polar regions.

METEOROLOGY.—The study dealing with the phenomena of the atmosphere. This includes not only the physics, chemistry, and dynamics of the atmosphere, but is extended to include many of the direct effects of the atmosphere upon Earth's surface, the oceans, and life in general.

MICROCLIMATE.—The fine climate structure of the air space that extends from the very surface of Earth to a height where the effects of the immediate character of the underlying surface no longer can be distinguished from the general local climate (mesoclimate or microclimate).

MIGRATORY.—Moving; commonly applied to pressure systems embedded in the westerlies and, therefore, moving in a general west-to-east direction.

MILLIBAR.—(abbreviated mb) A pressure unit of 1,000 dynes per centimeter, convenient for reporting atmospheric pressures.

MIRAGE.—A refraction phenomenon wherein an image of some object is made to appear displaced from its true position.

MOIST AIR.—In atmospheric thermodynamics, air that is a mixture of dry air and any amount of water vapor. Generally, air with a high relative humidity.

MOIST TONGUE.—An extension or protrusion of moist air into a region of lower moisture content. Cloudiness and precipitation are closely related to moist tongues.

MOISTURE.—A general term usually referring to the water vapor content of the atmosphere or to the total water substance (gas, liquid, and solid) present in a given volume of air.

MONSOON.—A name for seasonal wind. It was first applied to the winds over the Arabian Sea, which blow for 6 months from the northeast and 6 months from the southwest, but it has been extended to similar winds in other parts of the world.

MONSOON CLIMATE.—The type of climate that is found in regions subject to monsoons. It is best developed on the fringes of the tropics.

NEPHANALYSIS.—The analysis of a synoptic chart in terms of the types and amounts of clouds and precipitation.

NEPHCURVE.—In nephanalysis, a line bounding a significant portion of a cloud system—for example, a clear-skyline, a precipitation line, a cloud-type line, or a ceiling-height line.

NEUTRAL EQUILIBRIUM.—A property of the steady state of a system which exhibits neither instability nor stability according to the particular criterion under consideration. A disturbance introduced into such an equilibrium will thus be neither amplified nor damped.

NEUTRAL STABILITY.—The state of an unsaturated or saturated column. of air in the atmosphere when its environmental lapse rate of temperature is equal to the dry-adiabatic lapse rate or the saturation-adiabatic lapse rate, respectively. Under such conditions a parcel of air displaced vertically will experience no buoyant acceleration.

NEUTRAL WAVE.—Any wave whose amplitude does not change with time. In most contexts these waves are referred to as stable waves, the term *neutral wave* being used when it is important to emphasize that the wave is neither damped nor amplified.

NORTHEAST TRADES.—The trade winds of the Northern Hemisphere.

OCCLUDED FRONT.—(commonly called occlusion; also called frontal occlusion) A composite of two fronts, formed as a cold front overtakes a warm front or quasi-stationary front. This is a common process in the late stages of wave-cyclone development, but it is not limited to occurrence within a wave cyclone.

OCCLUSION.—Same as OCCLUDED FRONT.

OCEAN WEATHER STATION.—As defined by the World Meteorological Organization, a specific maritime location occupied by a ship equipped and staffed to observe weather and sea conditions and report the observations by international exchange.

OROGRAPHIC LIFTING.—The lifting of an air current caused by its passage up and over mountains.

OVERRUNNING.—A condition existing when an air mass is in motion aloft above another air mass of greater density at the surface. This term is usually applied in the case of warm air ascending the surface of a warm or quasi-stationary front.

PARAMETER.—(1) In general, any quantity of a problem that is not an independent variable. More specifically, the term is often used to distinguish, from dependent variables, quantities that may be more or less arbitrarily assigned values for purposes of the problem at hand. (2) Commonly and carelessly used by many meteorologists for almost any meteorological quantity or element.

PARTIAL PRESSURE.—The pressure of a single component of a gaseous mixture, according to Dalton's Law.

PERTURBATION.—Any departure introduced into an assumed steady state of a system. In synoptic meteorology, the term most often refers to any departure from zonal flow within the major zonal currents of the atmosphere. It is especially applied to the wave-like disturbances within the tropical easterlies.

PHOTOSPHERE.—The intensely bright portion of the Sun visible to the unaided eye. It is a shell a few hundred miles in thickness marking the boundary between the dense interior gases of the Sun and the more diffuse cooler gases in the outer portions of the Sun.

PLANETARY BOUNDARY LAYER.—(ako called friction layer or atmospheric boundary layer) That layer of the atmosphere from Earth's surface to the geostrophic wind level, including therefore, the surface boundary layer and the Eckman layer.

PLANETARY CIRCULATION.—The system of large-scale disturbances in the troposphere when viewed on a hemispheric or worldwide scale. Same as GENERAL CIRCULATION.

POLAR AIR.—A type of air whose characteristics are developed over high latitudes, especially within the subpolar highs. Continental polar air (cP) has low surface temperature, low moisture content, and, especially in its source regions, great stability in the lower layers. It is shallow in comparison with arctic air.

POLAR EASTERLIES.—The rather shallow and diffuse body of easterly winds located poleward of the subpolar low-pressure belt. In the mean in the Northern Hemisphere, these easterlies exist to an appreciable extent only north of the Aleutian low and Icelandic low.

POLAR FRONT.—According to the polar-front theory, the semipermanent, semicontinuous front separating air masses of tropical and polar origin. This is the major front in terms of air mass contrast and susceptibility to cyclonic disturbance.

POLAR-FRONT THEORY.—A theory originated by the Scandinavian school of meteorologists whereby a polar front, separating air masses of polar and tropical origin, gives rise to cyclonic disturbances which intensify and travel along the front, passing through various phases of a characteristic life history.

POLAR OUTBREAK.—The movement of a cold air mass from its source region; almost invariably applied to a vigorous equatorward thrust of cold polar air, a rapid equatorward movement of the polar front.

POLAR TROUGH.—In tropical meteorology, a wave trough in the westerlies having sufficient amplitude to reach the tropics in the upper air. At the surface it is reflected as a trough in the tropical easterlies, but at moderate elevations it is characterized by westerly winds. It moves generally from west to east and is accompanied by considerable cloudiness at all levels. Cumulus congestus and cumulonimbus clouds are usually found in and around the trough lines. The early and late season hurricanes of the western Caribbean frequently form in polar troughs.

POTENTIAL ENERGY.—The energy that a body possesses as a consequence of its position in the field of gravity; numerically equal to the work required to bring the body from an arbitrary standard level, usually taken as mean sea level, to its given position.

PRE-FRONTAL SQUALL LINE.—A squall line or instability line located in the warm sector of a wave cyclone, about 50 to 300 miles in advance of the cold front, usually oriented roughly parallel to the cold front and moving in about the same manner as the cold front.

PRESSURE CENTER.—On a synoptic chart, a point of local minimum or maximum pressure; the center of a low or high. It is also a center of cyclonic or anticyclonic circulation.

PRESSURE GRADIENT.—The rate of decrease (gradient) of pressure in space at a fixed time. The term is sometimes loosely used to denote simply the magnitude of the gradient of the pressure field.

PRESSURE GRADIENT FORCE.—The force due to differences of pressure within a fluid mass. In meteorological literature the term usually refers only to horizontal pressure force.

PRESSURE PATTERN.—The general geometric characteristics of atmospheric pressure distribution as revealed by isobars on a constant-height chart, usually the surface chart.

PRESSURE SYSTEM.—An individual cyclonic-scale feature of atmospheric circulation; commonly used to denote either a high or low, less frequently a ridge or trough.

PRIMARY CIRCULATION.—The prevailing fundamental atmospheric circulation on a planetary scale that must exist in response to (a) radiation differences with latitude, (b) the rotation of Earth, and (c) the particular distribution of land and oceans; and which is required from the viewpoint of conservation of energy.

PROMINENCE.—A filament-like protuberance from the chromosphere of the Sun.

QUASI-STATIONARY FRONT.—(Commonly called stationary front) A front that is stationary or nearly so. Conventionally, a front that is moving at a speed less than about 5 knots is generally considered to be quasi-stationary. In synoptic chart analysis, a quasi-stationary front is one that has not moved appreciably from its position on the last (previous) synoptic chart (3 or 6 hours before).

RADAR METEOROLOGICAL OBSERVATION.—An evaluation of the echoes that appear on the indicator of a weather radar, in terms of the orientation, coverage, intensity, tendency of intensity, height, movement, and unique characteristics of echoes that may be indicative of certain types of severe storms (such as hurricanes, tornadoes, or thunderstorms) and of anomalous propagation.

RADIATION.—(1) The process by which electromagnetic radiation is propagated through free space by virtue of joint undulatory variations in the electric and magnetic fields in space. This concept is to be distinguished from convection and conduction. (2) The process by which energy is propagated through any medium by virtue of the wave motion of that medium, as in the propagation of sound waves through the atmosphere, or ocean waves along the water surface.

RADIATIONAL COOLING.—The cooling of Earth's surface and adjacent air, accomplished (mainly at night) whenever Earth's surface suffers a net loss of heat due to terrestrial radiation.

RADIATION FOG.—A major type of fog, produced over a land area when radiational cooling reduces the air temperature to or below its dew point.

RADIOSONDE.—A balloon-borne instrument for the simultaneous measurement and transmission of meteorological data.

RADIOSONDE OBSERVATION.—(commonly contracted to raob) An evaluation in terms of temperature, relative humidity, and pressure aloft, of radio signals received from a balloon-borne radiosonde; the height of each mandatory and significant pressure level of the observation is computed from these data.

RAINBOW.—Any one of a family of circular arcs consisting of concentric colored bands, arranged from red on the inside to blue on the outside, which may be seenona“sheet” of water drops (rain, fog, or spray).

RAWIN.—A method of winds-aloft observation; that is, the determination of wind speeds and directions in the atmosphere above the station. It is accomplished by tracking a balloon-borne radar target or radiosonde transmitter with either radar or a radio direction-finder.

RAWINSONDE.—A method of upper-air observation consisting of an evaluation of the wind speed and direction, temperature, pressure, and relative humidity aloft by means of a balloon-borne radiosonde tracked by a radar or radio direction-finder. If radar is used for tracking, a radar target is also attached to the balloon. Thus, it is a radiosonde observation combined with a type of rawin observation.

RECURVATURE.—With respect to the motion of severe tropical cyclones (hurricanes and typhoons), the change in direction from westward and poleward to eastward and poleward. Such “recurvature” of the path frequently occurs as the storm moves into middle latitudes.

REDUCTION.—In general, the transformation of data from a “raw” form to some usable form. In meteorology, this often refers to the conversion of the observed value of an element to the value that it theoretically would have at some selected or standard level, usually mean sea level. The most common reduction in observing is that of station pressure to sea-level pressure.

REFLECTION.—The process whereby a surface of discontinuity turns back a portion of the incident radiation into the medium through which the radiation approached.

REFLECTIVITY.—A measure of the fraction of radiation reflected by a given surface; defined as the ratio of the radiant energy reflected to the total that is incident upon that surface. The reflectivity of a given surface for a specified broad spectral range, such as the visible spectrum or the solar spectrum, is referred to as albedo.

REFRACTION.—The process in which the direction of energy propagation is changed as the result of a change in density within the propagating medium, or as the energy passes through the interface representing a density discontinuity between two media.

RELATIVE VORTICITY.—The vorticity as measured in a system of coordinates fixed on Earth’s surface. Usually, only the vertical component of the vorticity is meant.

RESOLUTION.—The ability of an optical system to render visible separate parts of an object, or to distinguish between different sources of light.

RESULTANT WIND.—In climatology, the vectorial average of all wind directions and speeds for a given level at a given place for a certain period, as a month. It is obtained by resolving each wind observation into components from north and east, summing over the given period, obtaining the averages, and reconverting the average components into a single vector.

RETROGRADE.—The motion of an atmospheric wave or pressure system in a direction opposite to that of the basic flow in which it is embedded.

RIDGE.—A elongated area of relatively high atmospheric pressure. The most common use of this term is to distinguish it from the closed circulation of a high; but a ridge may include a high, and a high may have one or more distinct ridges radiating from its center.

SCATTERING.—The process by which small particles suspended in a medium of a different index of refraction diffuse a portion of the incident radiation in all directions.

SEA BREEZE.—A coastal local wind that blows from sea to land, caused by the temperature difference when the sea surface is colder than the adjacent land. Therefore, it usually blows on relatively calm, sunny, summer days; and alternates with the oppositely directed, usually weaker, nighttime land breeze.

SEA-BREEZE FRONT.—A sea breeze that forms out over the water, moves slowly toward the coast and then moves inland quite suddenly. Often associated with the passage of this type of sea breeze are showers, a sharp wind shift from seaward to landward, and a sudden drop in temperature. The leading edge of such a sea breeze is sometimes called the sea-breeze front.

SEA LEVEL.—The height or level of the sea surface.

SEASON.—A division of the year according to some regularly recurrent phenomena, usually astronomical or climatic. Astronomical seasons extend from an equinox to the next solstice (or vice versa). Climatic seasons are often based on precipitation (rainy and dry seasons).

SECONDARY CIRCULATION.—Atmospheric circulation features of synoptic scale.

SECONDARY FRONT.—A front that forms within a baroclinic cold air mass that itself is separated from a warm air mass by a primary frontal system. The most common type is the secondary cold front.

SHEAR.—The variation (usually the directional derivative) of a vector field along a given direction in space. The most frequent context for this concept is wind shear.

SHEAR LINE—A line or narrow zone across which there is an abrupt change in the horizontal wind component parallel to this line; a line of maximum horizontal wind shear.

SHORT WAVE.—With regard to atmospheric circulation, a progressive wave in the horizontal pattern of air motion with dimensions of synoptic scale, as distinguished from a long wave.

SHORT-WAVE RADIATION.—A term used loosely to distinguish radiation in the visible and near-visible portions of the electromagnetic spectrum (roughly 0.4 to 1.0 micron in wavelength) from long-wave radiation.

SIBERIAN HIGH.—A cold-core high--pressure area that forms over Siberia in winter, and which is particularly apparent on mean charts of sea-level pressure.

SINGULAR POINT.—In a flow field, a point at which the direction of flow is not uniquely determined, hence a point of zero speed, e.g., a col.

SMOOTHING.—An averaging of data in space or time, designed to compensate for random errors or fluctuations of a scale smaller than that presumed significant to the problem at hand; the analysis of a sea-level weather map smoothes the pressure field on a space-scale more or less systematically determined by the analyst by taking each pressure as representative not of a point but of an area about the point.

SOLAR CONSTANT.—The rate at which solar radiation is received outside Earth's atmosphere on a surface normal to the incident radiation, and at Earth's mean distance from the Sun.

SOLSTICE.—(1) Either of two points on the Sun's apparent annual path where it is displaced farthest, north or south, from Earth's equator. The Tropic of Cancer (north) and Tropic of Capricorn (south) are defined as the parallels of latitude that lie directly beneath a solstice. (2) Popularly, the time at which the Sun is farthest north or south; the "time of the solstice." In the Northern Hemisphere, the summer solstice falls on or about 21 June, and the winter solstice on or about 22 December. The reverse is true in the southern latitudes.

SOUNDING.—In meteorology, the same as upper-air observation.

SPECIFIC HEAT.—The heat capacity of a system per unit mass. That is, the ratio of the heat absorbed (or released) by unit mass of the system to the corresponding temperature rise (or fall).

SPECIFIC HUMIDITY.—In moist air, the ratio of the mass of water vapor to the total mass of the system. For many purposes it may be approximated by the mixing ratio.

SPECULAR REFLECTION.—Reflection in which the reflected radiation is not diffused; reflection as from a mirror.

SPIRAL BAND.—Spiral-shaped radar echoes received from precipitation areas within intense tropical cyclones. They curve cyclonically in toward the center of the storm and appear to merge to form the wall around the eye of the storm.

SQUALL LINE.—Any non-frontal line or narrow band of active thunderstorms.

STANDARD ATMOSPHERE.—A hypothetical vertical distribution of atmospheric temperature, pressure, and density which, by international agreement, is taken to be representative of the atmosphere for purposes of pressure altimeter calibrations, aircraft performance calculations, aircraft and missile design, ballistic tables, etc. The air is assumed to obey the perfect gas law and the hydrostatic equation, which, taken together, relate temperature, pressure, and density variations in the vertical. It is further assumed that the air contains no water vapor and that the acceleration of gravity does not change with height.

STEERING CURRENT.—A basic fluid flow that exerts a strong influence upon the direction of movement of disturbances embedded in it.

STEERING LEVEL.—A level, in the atmosphere, where the velocity of the basic flow bears a direct relationship to the velocity of movement of an atmospheric disturbance embedded in the flow.

STORM.—Any disturbed state of the atmosphere, especially as affecting Earth's surface, and strongly implying destructive or otherwise unpleasant weather. Storms range in scale from tornadoes and thunderstorms, through tropical cyclones, to widespread extratropical cyclones.

STORM SURGE.—(also called storm tide) An abnormal rise of the sea along a shore as the result, primarily, of storm winds.

STRATOSPHERE.—The atmospheric shell above the troposphere and below the mesosphere. It extends, therefore, from the tropopause to the height where the temperature begins to increase in the 20- to 25-km region.

STREAMLINE.—A line whose tangent at any point in a fluid is parallel to the instantaneous velocity of the fluid at that point.

SUBGRADIENT WIND.—A wind of lower speed than the gradient wind required by the existing pressure gradient and centrifugal force.

SUBLIMATION.—The transition of a substance from the solid phase directly to the vapor phase, or vice versa, without passing through an intermediate liquid phase.

SUBSIDENCE.—A descending motion of air in the atmosphere, usually with the implication that the condition extends over a rather broad area.

SUBSIDENCE INVERSION.—A temperature inversion produced by the adiabatic warming of a layer of subsiding air. This inversion is enhanced by vertical mixing of the air layer below the inversion.

SUBTROPICAL HIGH.—One of the semipermanent highs of the subtropical high-pressure belt. They appear as centers of action on mean charts of surface pressure. They lie over oceans and are best developed in summer.

SUBTROPICAL HIGH-PRESSURE BELT.—One of the two belts of high atmospheric pressure that are centered, in the mean, near 30°N and 30°S latitudes.

SUNSPOT.—A relatively dark area on the surface of the Sun, consisting of a dark central umbra surrounded by a penumbra, which is intermediate in brightness between the umbra and the surrounding photosphere.

SUPERADIABATIC LAPSE RATE.—An environmental lapse rate greater than the dry-adiabatic lapse rate, such that potential temperature decreases with height.

SUPERCOOLING.—The reduction of temperature of any liquid below the melting point of that substance's solid phase, that is, cooling beyond its nominal freezing point.

SUPERGRADIENT WIND.—A wind of greater speed than the gradient wind required by the existing pressure gradient and centrifugal force.

SUPERIOR AIR.—An exceptionally dry mass of air formed by subsidence and usually found aloft but occasionally reaching Earth's surface during extreme subsidence processes.

SUPERIOR MIRAGE.—A spurious image of an object formed above its true position by abnormal refractive conditions; opposite of *inferior mirage.*

SUPERSATURATION.—The condition existing in a given portion of the atmosphere (or other space) when the relative humidity is greater than 100 percent, that is, when it contains more water vapor than is needed to produce saturation with respect to a plane surface of pure water or pure ice.

SURFACE BOUNDARY LAYER.—That thin layer of air adjacent to Earth's surface, extending up to the so-called anemometer level (the height above the ground at which an anemometer is exposed; usually 10 meters to 100 meters.

SURFACE CHART.—(also called surface map, sea-level chart, sea-level pressure chart) An analyzed synoptic chart of surface weather observations. It shows the distribution of sea-level pressure (positions of highs, lows, ridges, and troughs) and the location and nature of fronts and air masses. Often added to this are symbols of occurring weather phenomena, analysis of pressure tendency (isallobars), indications of the movement of pressure systems and fronts, and perhaps others, depending on the use of the chart.

SURFACE INVERSION.—A temperature inversion based at Earth's surface; that is, an increase of temperature with height beginning at ground level.

SURFACE OF DISCONTINUITY.—A surface separating two fluids across which there is a discontinuity of some fluid property, such as density, velocity, etc., or of some derivative of one of these properties in a direction normal to the interface. An atmospheric front is represented ideally by a surface of discontinuity of velocity, density, temperature, and pressure gradient; the tropopause is represented ideally by a surface of discontinuity of, for example, the derivatives: lapse rate and wind shear.

SYNOPTIC.—In general, pertaining to or affording an overall view. In meteorology, this term has become somewhat specialized in referring to the use of meteorological data obtained simultaneously over a wide area for the purpose of presenting a comprehensive and nearly instantaneous picture of the state of the atmosphere.

SYNOPTIC CHART.—In meteorology, any chart or map on which data and analyses are presented that describe the state of the atmosphere over a large area at a given moment in time.

SYNOPTIC SCALE.—The scale of the migratory high- and low-pressure systems (or cyclonic waves) of the lower troposphere, with wavelengths of 1,000 to 2,500 km.

SYNOPTIC SITUATION.—The general state of the atmosphere as described by the major features of synoptic charts.

TEMPERATURE INVERSION.—A layer in which temperature increases with altitude.

TERTIARY CIRCULATION.—The generally small, localized atmospheric circulations. They are represented by such phenomena as the local winds, thunderstorms, and tornadoes.

THERMAL.—(1) Pertaining to temperature or heat. (2) A relatively-small-scale rising current of air produced when the atmosphere is heated enough locally by Earth's surface to produce absolute instability in its lower layers. The use of this term is usually reserved to denote those currents either too small and/or too dry to produce convective clouds; thus, thermals are a common source of low-level clear-air turbulence.

THERMAL GRADIENT.—The rate of variation of temperature either horizontally or vertically.

THERMAL HIGH.—An area of high pressure resulting from the cooling of air by a cold underlying surface, and remaining relatively stationary over the cold surface.

THERMAL LOW.—An area of low atmospheric pressure resulting from high temperatures caused by intense surface heating. They are stationary with a generally weak and diffuse cyclonic circulation. They are non-frontal.

THERMAL WIND.—The mean wind-shear vector in geostrophic balance with the mean temperature gradient of a layer bounded by two isobaric surfaces.

THERMOSPHERE.—The atmospheric shell extending from the top of the mesosphere to outer space. It is a region of more or less steadily increasing temperature with height, starting at 70 or 80 km.

THICKNESS.—In synoptic meteorology, the vertical depth, measured in geometric or geopotential units, of a layer in the atmosphere bounded by surfaces of two different values of the same physical quantity, usually constant-pressure surfaces.

THICKNESS CHART.—A type of synoptic chart showing the thickness of a certain physically defined layer in the atmosphere. It almost always refers to an isobaric thickness chart, that is, a chart of vertical distance between two constant-pressure surfaces. It consists of a pattern of thickness lines either drawn directly to data plotted on the chart or, more commonly, drawn by the single graphical process of differential analysis.

THICKNESS LINE.—A line drawn through all geographic points at which the thickness of a given atmospheric layer is the same; an isopleth of thickness.

TORNADO.—A violently rotating column of air, pendant from a cumulonimbus cloud, and nearly always observable as a “funnel cloud” or tuba.

TRADE-WIND CUMULUS.—The characteristic cumulus cloud in average, undisturbed, weather conditions over the trade-wind belts.

TRADE-WIND INVERSION.—A characteristic temperature inversion usually present in the the trade-wind streams over the eastern portions of the tropical oceans.

TRADE WINDS.—The wind system, occupying most of the tropics, that blows from the subtropical highs toward the equatorial trough.

TRIPLE POINT.—Term commonly used to denote the apex of an occlusion.

TROPICAL AIR.—A type of air whose characteristics are developed over low latitudes. Maritime tropical air (mT) is produced over the tropical and subtropical seas, while continental tropical air is produced over subtropical arid regions.

TROPICAL CYCLONE.—The general term for a cyclone that originates over the tropical oceans. By international agreement, tropical cyclones are classified according to their intensity (the strength of their surface winds).

TROPICAL DEPRESSION.—A tropical cyclone having a slight surface circulation (at least one closed isobar) and surface winds less than 34 knots.

TROPICAL DISTURBANCE.—An area of disturbed weather over the tropical oceans that often develops into a tropical cyclone.

TROPICAL EASTERLIES.—A term applied to the trade winds when they are shallow and exhibit a strong vertical shear. With this structure, at about 5,000 feet the easterlies give way to the upper westerlies, which are sufficiently strong and deep to govern the course of cloudiness and weather. They occupy the poleward margin of the tropics in summer and can cover most of the tropical belt in winter.

TROPICAL STORM.—A tropical cyclone whose surface winds have attained speeds between 34 and 63 knots.

TROPOPAUSE.—The boundary between the troposphere and stratosphere, usually characterized by an abrupt change of lapse rate.

TROPOSPHERE.—That portion of Earth’s atmosphere extending from the surface to the tropopause; that is, the lowest 10 to 20 km of the atmosphere.

TROUGH.—An elongated area of low atmospheric pressure; the opposite of a ridge.

TRUE NORTH.—The direction from any point on Earth’s surface toward the geographic North Pole; the northerly direction along any projection of Earth’s axis upon Earth’s surface, for example, along a longitude line. Except for much of navigational practice (which uses magnetic north), true north is the universal 0° (or 360°, mapping reference.

UPPER AIR.—In synoptic meteorology and weather observing, that portion of the atmosphere which is above the lower troposphere. No distinct lower limit is set, but the term is generally applied to the levels above 850 mb.

UPPER ATMOSPHERE.—The general term applied to the atmosphere above the troposphere.

UPPER FRONT.—A front that is present in the upper air but does not extend to the ground.

UPPER-LEVEL HIGH.—(also called upper-level anticyclone, upper high, high aloft) An anticyclonic circulation existing in the upper air. This often refers to such highs only when they are much more pronounced at upper levels than at the surface.

UPPER-LEVEL LOW.—(also called upper-level cyclone, upper cyclone, high-level cyclone, low aloft) A cyclonic circulation existing in the upper air, specifically as seen on an upper-level constant-pressure chart. This term is often restricted to such lows having little cyclonic circulation in the lower atmosphere.

UPPER-LEVEL RIDGE.—A pressure ridge existing in the upper air, especially one that is stronger aloft than near Earth's surface.

UPPER-LEVEL TROUGH.—A pressure trough existing in the upper air. This term is sometimes restricted to those troughs that are much more pronounced aloft than near Earth's surface.

UPSTREAM.—In the direction from which a fluid is flowing.

UPWIND.—In the direction from which the wind is blowing.

VECTOR.—Any quantity, such as force, velocity, or acceleration, that has both magnitude and direction at each point in space, as opposed to a scalar, which has magnitude only. Geometrically, it is represented by an arrow of length proportional to its magnitude, pointing in the assigned direction.

VEERING.—A change in wind direction in a clockwise sense in the Northern Hemisphere and counterclockwise direction in the Southern Hemisphere.

VERNAL EQUINOX.—For either hemisphere, the equinox at which the Sun's most direct rays approach from the opposite hemisphere. In northern latitudes, this occurs approximately on 21 March; the Sun's most direct rays are centered over the equator and moving north.

VIRTUAL TEMPERATURE.—In a system of moist air, the temperature of dry air having the same density and pressure as the moist air. It is always greater than the actual temperature.

VORTEX.—In its most general use, any flow possessing vorticity. More often the term refers to a flow with closed streamlines.

VORTICITY.—A vector measure of local rotation in a fluid flow.

WARM-CORE HIGH.—At a given level in the atmosphere, any high that is warmer at its center than at its periphery.

WARM-CORE LOW.—At a given level in the atmosphere, any low that is warmer at its center than at its periphery.

WARM FRONT.—Any non-occluded front or portion thereof that moves in such a way that warmer air replaces colder air.

WARM SECTOR.—That area within the circulation of a wave cyclone where the warm air is found. It lies between the cold front and the warm front of the storm; and, in the typical case, the warm sector continually diminishes in size and ultimately disappears (at the surface) as the result of occlusion.

WARM TONGUE.—A pronounced poleward extension or protrusion of warm air.

WAVE CYCLONE.—A cyclone that forms and moves along a front.

WAVE THEORY OF CYCLONES.—A theory of cyclone development based upon the principles of wave formation on an interface between two fluids. In the atmosphere, a front is taken as such an interface.

WEATHER.—The state of the atmosphere, mainly with respect to its effect upon life and human activities.

WEATHER RADAR.—Generally, any radar that is suitable or can be used for the detection of precipitation or clouds.

WESTERLIES. —(also known as circumpolar westerlies, counter-trades, middle-latitude westerlies, midlatitude westerlies, polar westerlies, subpolar westlies, subtropical westerlies, temperate westerlies, zonal westerlies, and zonal winds) Specifically, the dominant west-to-east motion of the atmosphere, centered over the middle latitudes of both hemispheres. At the surface, the westerly belt extends, on the average, from about 35° to 65° latitude. At upper levels, the westerlies extend farther equatorward and poleward. The equatorward boundary is fairly well defined by the subtropical high-pressure belt; the poleward boundary is quite diffuse and variable.

WHITEOUT.—An atmospheric optical phenomenon of the polar regions in which the observer appears to be engulfed in a uniformly white glow. Shadows, horizon, and clouds are not discernible; sense of depth and orientation are lost; only very dark, nearby objects can be seen.

WIND-CHILL FACTOR.—The cooling effect of any combination of temperature and wind, expressed as the loss of body heat, in kilogram calories per hour per square meter of skin surface. The wind-chill: factor. is based on the cooling rate of a nude body in the shade; It is only an approximation, because of individual body variations in shape, size, and metabolic rate.

WIND ROSE.—Any one of a class of diagrams designed to show the distribution of wind direction experienced at a given location over a considerable period; it thus shows the prevailing wind direction. The most common form consists of a circle from which 8 or 16 lines emanate, one for each compass point. The length of each line is proportional to the frequency of wind from that direction, and the frequency of calm conditions is entered in the center.

WINTER SOLSTICE.—For either hemisphere, the solstice at which the Sun is above the opposite hemisphere. In northern latitudes, the time of this occurrence is approximately 22 December.

ZONAL.—Latitudinal; easterly or westerly; opposed to meridional.

ZONAL FLOW.—The flow of air along a latitude circle; more specifically, the latitudinal (east or west) component of existing flow.

ZONAL INDEX.—A measure of strength of the midlatitude westerlies, expressed as the horizontal pressure difference between 35° and 55° latitude or as the corresponding geostrophic wind.

APPENDIX II

TROPICAL CYCLONE INTENSITY ANALYSIS TECHNIQUE

'EIR' ANALYSIS DIAGRAM

Vernon F. Dvorak (April 1984)

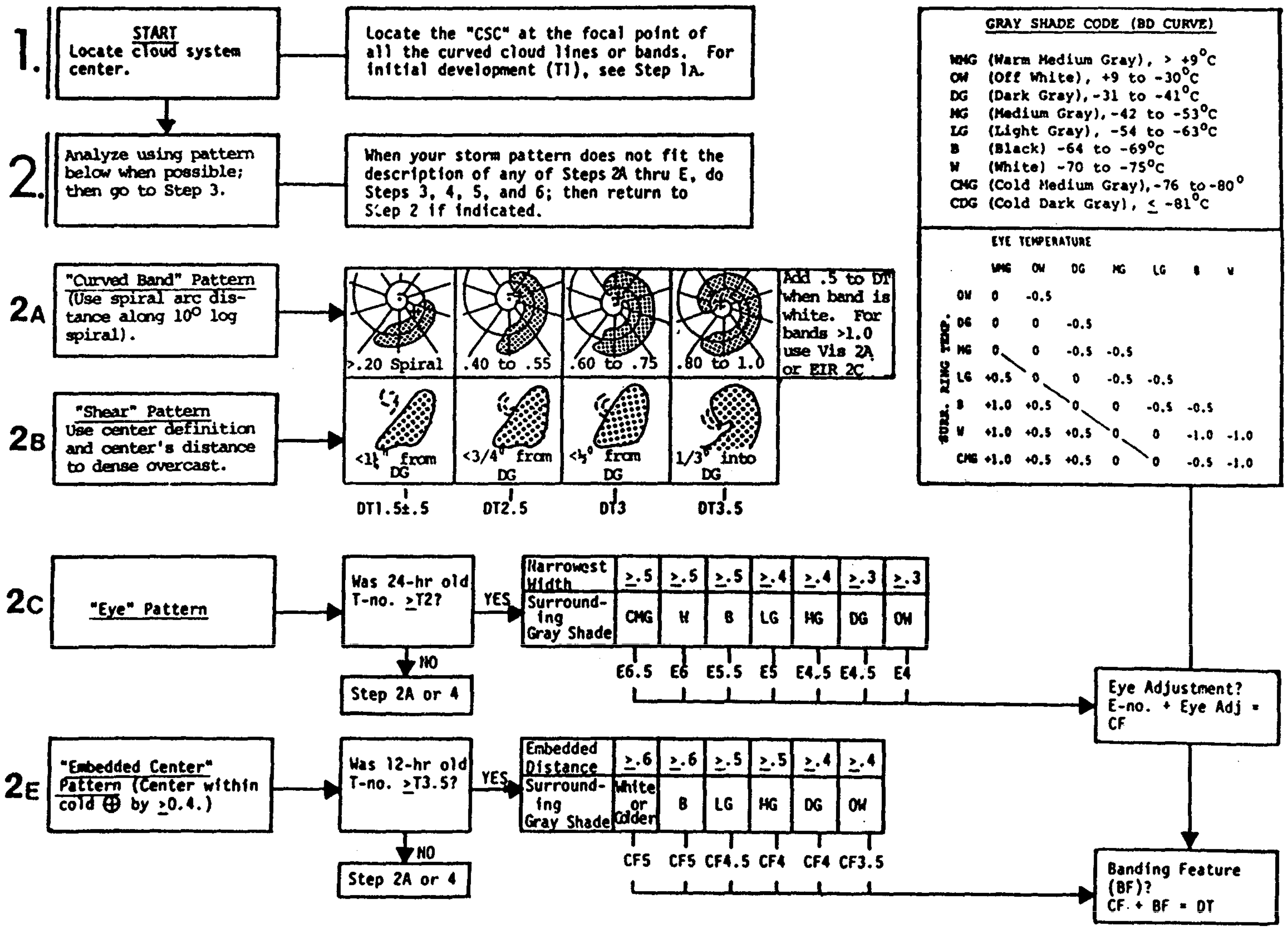


Figure 1. EIR Analysis Diagram, Part 1.

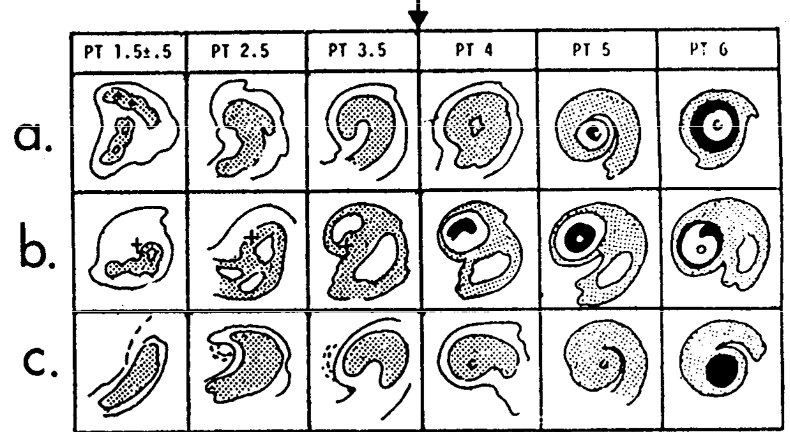
3. "Central Cold Cover" Pattern

Rules: When past T-no. ≤T3, maintain model trend for 12 hours; then hold same. When past T-no. ≥T3.5 hold T-no. same. Use as final T-no.; then go to Step 9.

4. Determine past 24-hour trend. Is Development, Weakening, or Same indicated in a change of:
(a) center or eye characteristics, or
(b) center's involvement with the cold overcast.

5. Determine Model Expected T-no. (MET).

6. Determine pattern T-no. Select pattern in diagram that best matches your storm picture within one column of the MET. Adjust MET ± .5 when indicated.



*When hatched part of these patterns is white or colder, add .5 to pattern number.

7. <u>T-no. Determination</u>:

1. Use data T-no. from Step 2 when cloud features are clear-cut.
2. Use Pattern T-no. when DT is not clear and adjustment to MET is made.
3. For all other cases, use the MET.

8. <u>Final T-number Constraints</u>:

1. Initial classification must be T1 or T1.5.
2. During first 48 hours of development, T-no. cannot be lowered at night.
3. 24 hrs after initial T1, storm's T-no. must be ≤T2.5.
4. Final T-no. limits: <T4: change of 1/2 over 6 hrs. >T4: change of 1 over 6 hrs, 1.5 over 12 hrs, 2 over 18 hrs, and 2.5 over 24 hrs.
5. Final T-no. must = MET ±1.

9. <u>Current Intensity (CI) Number Rules</u>:

1. Use CI = final T-no. except when final T-no. shows change to weakening trend, or when redevelopment is indicated.
2. For initial weakening, hold CI same for 12 hours, then hold CI ½ or 1 higher than T-no. as storm weakens.

10. <u>24-Hr Forecast</u>:

Extrapolate past trend unless one of the five rules in the instructions applies.

Figure 2. EIR Analysis Diagram, Part 2.

'VIS' ANALYSIS DIAGRAM

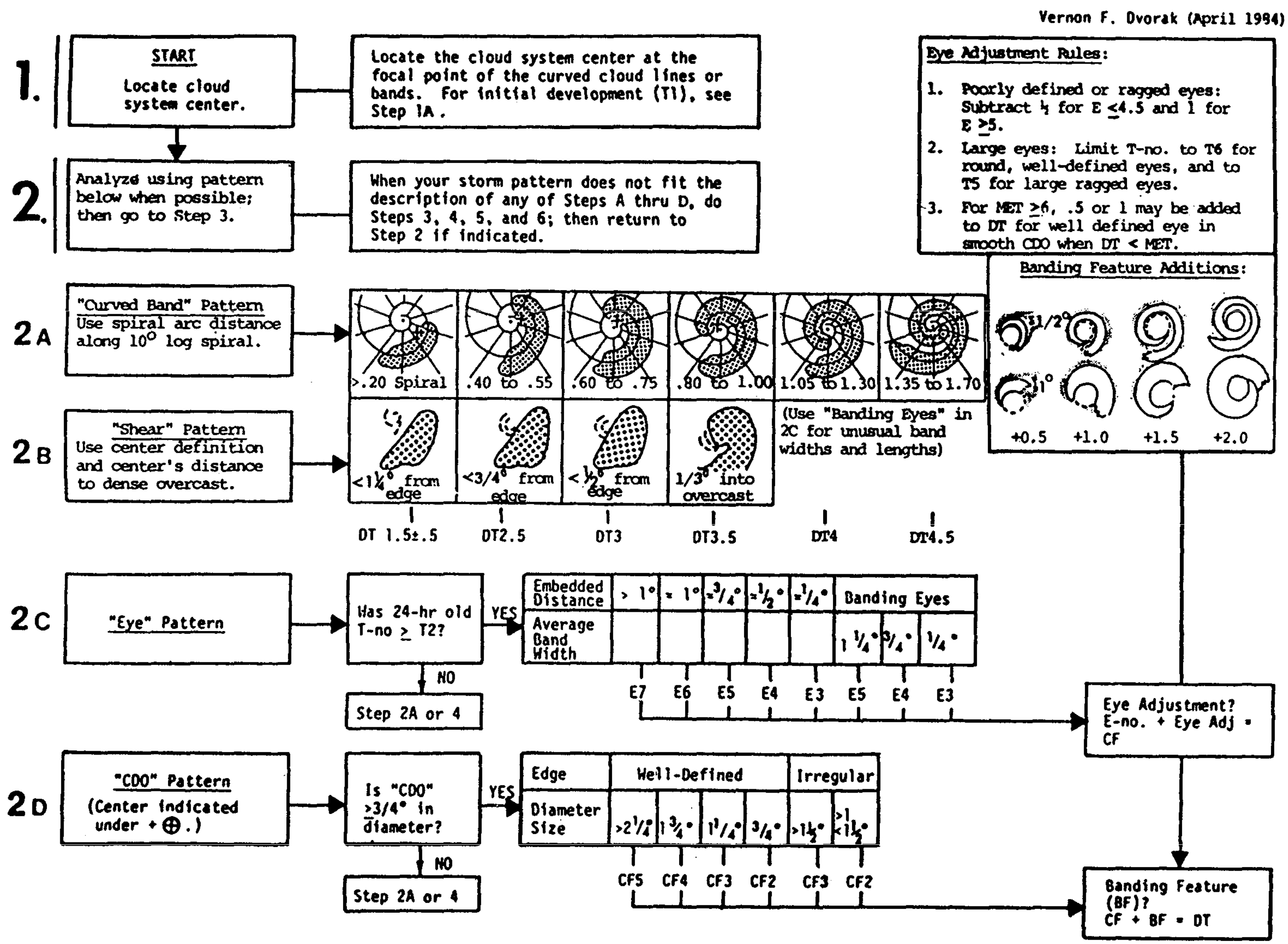


Figure 3. VIS Analysis Diagram, Part 1.

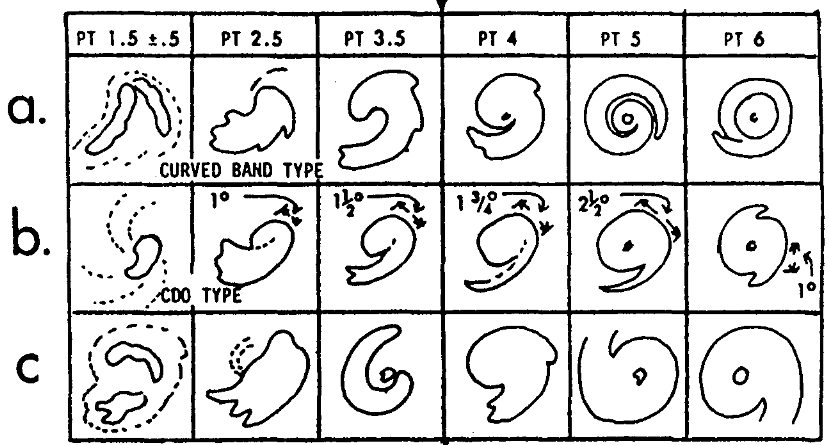
3. "Central Cold (Dense) Cover" Pattern

Rules: When past T-no. $\leq$T3, maintain model trend for 12 hours; then hold same. When past T-no. $\geq$T3.5 hold T-no. same. Use as final T-no.; then go to Step 9.

4. Determine past 24-hour trend. Is Development, Weakening, or Same indicated in a change of:
(a) center or eye characteristics, or
(b) center's involvement with dense overcast.

5. Determine Model Expected T-no. (MET).

6. Determine pattern T-no. Select pattern in diagram that best matches your storm picture within one column of the MET. Adjust MET .5 when indicated.



When cloud comma is extremely small (<2½° lat), subtract 1 from pattern number.

7. T-no. Determination:

1. Use data T-no. from Step 2 when cloud features are clear-cut.
2. Use Pattern T-no. when DT is not clear and adjustment to MET is made.
3. For all other cases, use the MET.

8. Final T-number Constraints:

1. Initial classification must be T1 or T1.5.
2. During first 48 hours of development, T-no. cannot be lowered at night.
3. 24 hrs after initial T1, storm's T-no. must be $\leq$T2.5.
4. Final T-no. limits: <T4: change of 1/2 over 6 hrs. >T4: change of 1 over 6 hrs, 1.5 over 12 hrs, 2 over 18 hrs, and 2.5 over 24 hrs.
5. Final T-no. must = MET ±1.

9. Current Intensity (CI) Number Rules:

1. Use CI = final T-no. except when final T-no. shows change to weakening trend, or when redevelopment is indicated.
2. For initial weakening, hold CI same for 12 hours, then hold CI ½ or 1 higher than T-no. as storm weakens.

10. 24-Hr Forecast:

Extrapolate past trend unless one of the five rules in the instructions applies.

Figure 4. VIS Analysis Diagram, Part 2.

TROPICAL CYCLONE ANALYSIS WORKSHEET

Vernon F. Dvorak
June 1983

T-NUMBER ESTIMATE FROM MEASUREMENTS FOR DATA T-NUMBER (DT) COMPUTATION

T-NUMBER ESTIMATE FROM MODEL (AND DT CONSTRAINTS)

STEP →	1		2A,B				2C				2D	2E	Data T-Number Computation			3	4	5	6	7,8	9	10		INITIALS
DESCRIPTION →	Location		Curved Band or Shear				Eye		$E_{No}+E_{Adj}=CF$		CDO	Emb. Centr.				CCC	Trend	MET	PAT	FT	CI	24-Hr. Fcst.		
RULES →	Locate Cloud System Center at focal point of cloud curvature		Use Spiral Arc Length								Use Size		CF+BF=DT			Use Rules	24-Hr change			Use Rules		Adj. Model Fcst. if nec.		
DATE/TIME	LAT	LONG	DT 1.5	DT 2.5	DT 3.5	DT 4.5	(VIS) Use Embedded Distance	(EIR) Use Surrounding Temperature	From Rules E_{No}	Eye Definition E_{Adj}	Central Dense Overcast	(EIR) Use Surrounding Temperature	CF	BF	DT	Central Cold Cover	D-developing W-weakening S-same	Model Expected T-Number	Pattern T-Number	Final T-Number	Current Intensity Number	List Rule Used	Forecast Intensity Number	

Figure 5. Analysis Worksheet

INTENSITY ANALYSIS PROCEDURES AND RULES

STEP 1. LOCATE THE CLOUD SYSTEM CENTER (CSC)

The cloud system center is defined as the focal point of all the curved lines or bands of the cloud system. It can also be thought of as the point toward which the curved lines merge or spiral.
Procedure:

(1) The CSC is located at the center of the eye or at the center of curvature of a partial eye wall when one of these features is observed.

(2) When the CSC is not obvious, locate the model expected CSC. Draw a line along the “curved band axix” through the most dense (coldest) portion of the bandm The axis should roughly parallel the concave (inner) overcast boundary of the band. Locate the model expected center location in relation the the curved band. (See plus symbols in diagram in Step 2A.) The center is located near the inner (concave) edge of the band on the counterclockwise end (comma head) portion of the band. Locate tightly curved lines, merging lines, or CDO near the point where the center is expected to fall. The CSC is located at the center of curvature, near the point of mergence or at the center of the CDO (for CDO of _< 1 1/2° latitude in size). For large CDO’s, the center is sometimes defined by an arc of overshooting cloud tops or in an isolated cluster of convective tops. When not visible, use (3) below.

(3) When features are not visible at the expected CSC, or when the curved band is not apparent, use the circle method. The method consists of first drawing lines following the cloud line curvature or curved boundaries that fall within the curve of the curved band axis, and then fitting circles to the lines with tightest curvature.The CSC is located at the center of the area common to the circles. For relatively circular embedded center patterns of >T3.5 intensity, fit a log 10° spiral overlay to the curved band axis to locate center.

(4) When a cloud minimum wedge is visible on the concave side of the band near its middle, the CSC is located at the midpoint of a line drawn between the deepest cloud minimum incursion of the wedge and the counterclockwise extremity of the curved band axis. This method is frequently used with EIR pictures. In EIR pictures, the center is often located in the tight gradient near the coldest part of the pattern.

(5) When the location of the CSC is unclear, or could be placed at different locations, use all the methods above along with an extrapolation from the past track positions in making the final decision.

(6) When more than one well-defined CSC is apparent, use the one defined by the strongest appearing, lowest level cloud lines that best fits the past track of the storm. When strong vertical shear is apparent, remember that the upper level (dense) clouds will not be centered directly over the low-level center, but will be displaced with the CSC on the tight temperature gradient (sharp boundary) side of the dense cloud pattern.

Step 1A. Initial Development

The earliest signs of tropical cyclone development are observed about 1 1/2 days before a disturbance reaches tropical storm strength. At this time, the disturbance is classified a T1. A T1 is first used when a cluster of deep layer convective clouds showing line or band curvature has the following three properties.

(1) It has persisted for 12 hours or more.

(2) It has a cloud system center defined within an area having a diameter of 2 1/2° latitude or less which has persisted for 6 hours.

(3) It has an area of dense, cold (DG or colder) overcast* of >1 1/2° in extent that appears less than 2° from the center. The overcast may also appear in cumulonimbus lines the curve around the center.

The cloud system center will be defined in one of the following ways:

(1) Curved band, a dense (DG or colder) overcast band that shows some curvature around a relatively warm (cloud minimum) area. It should curve at least one-fifth the distance around a 10° log spiral. Cirrus, when visible, will indicate anticyclonic shear across the expected CSC. (See diagrams, Step 6, PT 1.5 pattern types.)

(2) Curved cirrus lines indicating a center of curvature within or near a dense, cold (DG or colder) overcast. (See Figure 4, Step 6, PT 1.5b.)

(3) Curved low cloud lines showing a center of curvature within 2° of a cold (DG or colder) cloud mass. (See diagrams, Step 2B, DT 1.5 pattern.)

In many cloud clusters that eventually develop, the northern boundaries show a straightening about 1 1/2 days prior to the T1 classifications. During the organizing stage of the T1 pattern, there may be extreme variability in the cloud pattern. In most developments at the T1 stage, strong upper-level horizontal anticyclonic shear will be indicated across the disturbance center when curved cirrus lines are present to reveal the shear. These upper level clouds. may indicate patterns far more advanced than T1 at the time of the initial classification. These patterns do not involve deep tropospheric circulations at this time and will be short lived. This means that the Day-2 data T-number may at times be less the Day-1's, but still development is indicated as long as theDT is 2 or more. There may also be times during the first two days of development when cirrus or convective clouds are almost absent, showing little pattern during the nighttime hours. This usually does not mean the storm is weakening. The rule is to never lower the T-number at night during the first 24 hours of development. A flat boundary rotating clockwise across the north side of the pattern throughout the period is a good sign of development. Note that a classification of T1 forecasts tropical storm

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*The amount of cold overcast may decrease during the subsequent nighttime hours making it crucial that the analyst watch for the required amount of overcast when it occurs.

intensity (T2.5) 36 hours after the T1 observation only when the environment is expected to remain favorable. A minus symbol is used after the T1 to indicate a T1 pattern that is not expected to develop. (See step 11.)

STEP 2. DETERMINE THE PATTERN TYPE THAT BEST DESCRIBES YOUR DISTURBANCE AND MEASURE CLOUD FEATURES AS INDICATED

The manner in which the cloud system center is defined determines the pattern to be analyzed. The pattern types listed below are described on the following pages. When the cloud pattern being analyzed does not resemble one of the patterns, proceed to Step 3.

Step 2A. "Curved Band" Pattern
Step 2B. "Shear" Pattern
Step 2C. "Eye" Pattern
Step 2D. Central Dense Overcast (CDO) Pattern
Step 2E. Embedded Center Pattern

General Analysis Rules:

1. When short-interval pictures are available, use the average measurement of all of the pictures with well-defined features taken within the 3 hour period ending at analysis time.

2. When two or more T-number estimates are made from the same picture, use the estimate closest to the MET.

3. When in doubt concerning ambiguous features, bias the analysis toward the MET.

Step 2A. Curved Band Pattern

The intensity estimate determined from this pattern type is derived by measuring the arc length of the curved band fitted to a 10° logarithm spiral overlay. (A circle will give the same answer most of the time.) The intensity values that relate to the curved band length are given in the analysis diagrams, Figure 1,3. Curved band measurements may be used with both VIS and EIR pictures until an intensity of DT 4.5 is reached. For EIR patterns greater than DT3.5 use measurements from VIS diagram.

The spiral overlay is fitted to the curvature of the dense (cold) band by first drawing a line along the "curved band axis" and then fitting the spiral curve to the line drawn. The curved band axis is defined as the axis of the coldest overcast gray shade (most dense clouds) within the cloud band. The line should roughly parallel the overcast edge on the concave side of the band. When the band indicates two possible axes, use the one with tightest curvature. Cellular cold globs that do not fall in line with the curve of the comma band are ignored when drawing the line. Fit the spiral to the line drawn on the picture and measure the spiral arc length of the dense (cold) band that follows the spiral curve.

In EIR patterns (like those in Figure 2, Step 6, Row b), the cold comma band will often show warm breaks through its middle. These breaks will appear to be almost clear in the VIS picture, When this occurs, draw the comma axis as though it were continuous through the breaks paralleling the edge of the cloud minimum incursion into the concave side of the band. As the curved band pattern evolves it will usually be defined by the dark gray shade of the BD curve, but may at times appear defined in warmer or colder shades of gray. At times the boundaries of the band must be interpreted from its form in previous pictures.

During the first 2 days of development (T1 to T2), the amount of overall band curvature may change excessively, very little, or even decrease somewhat for short periods even though typical development is occurring. For this reason, the tendency should be to raise the T-number by one during the first 24 hours of development as long as the band remains curved enough for T2 and clear signs of weakening or rapid development are not apparent. It is also important to allow at least 24 hours to pass between a T2 and a T4 classification. Even though the coiling process has been observed to be faster than this at times, the surface pressure does not fall accordingly.

During the T2.5 or T3 stage, a tightly curved band < 1 1/4° diameter of curvature observed within the curve of the broad curved band can also be, used as an indicator of tropical storm intensity. This is evidence that the wall cloud is forming. This tight curvature at weak tropical storm intensity is often ragged in appearance but will have deep-layer convective cloudiness on nearly opposite sides of a system center.

<u>Step 2B. Shear Patterns</u>

Shear patterns appear in pre-hurricane stages of development when vertical shear prevents the cold clouds from bending around the cloud system center as they do in the curved band patterns. The pattern may also appear after the hurricane stage has weakened to a pre-hurricane pattern because of increasing vertical shear.

The intensity estimate determined from this pattern type is derived by (1) the way in which the cloud system center is defined and (2) the distance between the low cloud center and the dense, cold overcast. For shear patterns associated with tropical storm intensity (T2.5 to T3.5), the center will be defined by parallel, circularly curved low cloud lines with a diameter of about 1.5° latitude or less. They indicate a center either near the edge or under the edge of a dense, cold (DG or colder) overcast cloud mass (see patterns in Step 2B, Figures 1,3. During the weaker stages of development (T1.5 + .5), the low cloud center will either be poorly defined in spiral lines within 1.25° of the cold overcast, circularly defined but some distance (>1.25° latitude) from the cold overcast clouds, or circularly defined near a small amount (<1 1/2° diameter) of dense overcast.

<u>Step 2C. Eye Pattern</u>

Eye patterns are analyzed in this step only when the eye falls near the point of the expected cloud system center, and after a T2 or greater pattern has been observed 24 hours prior to the current observation.

The eye is defined as one of the following:

(1) A warm (dark) spot in a dense, cold (OW or colder) overcast. (When more than one dark spot appears near the CSC, use the center closest to the expected center location.)

(2) A point in a dense, cold (OW or colder) overcast centered within the curvature of a colder (denser) band that curves at least halfway around the point with a diameter of curvature of 1 1/2° latitude or less.

(3) A spiral band wrapped around a relative warm (dark) spot with a diameter of curvature of 1 1/2° latitude or less. The band must curve at least 1.0 the distance around the 10° log spiral curve. (See pattern labeled DT 4 in figure 3, 2A.

The analysis of the eye pattern involves three computations: The eye number (E), the eye adjustment factor (Eye Adj), and the banding feature (BF) number. The equation is: CF + BF = DT {data T-number), where CF = E no. + Eye Adj.

1. EIR only (See 2. for VIS)

a. E (eye) number. To get the E or eye number, first determine the coldest gray shade that surrounds the relatively warm spot. Make certain that the minimum width of this grav shade meets the ““narrowest width” requirement shown in the diagram. When a spiral eye is defined, use the average width of the spiral band to determine the narrowest width criteria.

b. Eye Adjustment Factor. The eye adjustment factor is determined by using the graph in Figure 6. The graph is a plot of eye temperatures versus the temperature of the coldest ring or spiral that completely encircles the eye. This provides an adjustment of +_0.5, +_1, or 0 to the “E” number. No plus adjustment can be made for large eyes (>_ 3/4° diameter within the surrounding gray shade) or elongated eyes. When no previous subtraction was made, .5 is subtracted for elongated eyes having E numbers of > 4.5. Elongated eyes are defined as those having a short axis of <2/3 the long axis within the surrounding gray shade.

c. Banding Feature (BF). The BF addition is used with EIR pictures only when the T-number estimate without the BF is lower than the model expected T-number. It is defined only for patterns of CF4 or more that contain a clear-cut comma tail band that:

(1) curves 1/4 or more of the distance around the central features or comma head,

(2) is cold (MG or colder), and

(3) has a warm wedge (DG or warmer) between the tail and the central features that cuts at least halfway through the pattern for patterns a and b, Figure 7, and at least 2/3 the way for pattern c.

2. VIS only (See 1 above for EIR)

a. The E (eye) number is obtained by measuring the distance the eye is embedded in dense overcast clouds. The embedded distance of the eye is measured outward from the center of the eye to the nearest outside edge of the dense overcast for small (<30nm) eyes. For large eyes, measure outward from the inner wall of the eye. When a banding-type eye is indicated, the arc length of the band around the eye and the average width of the band surrounding the eye are important to the intensity determination, as indicated in the diagram. See analysis diagram (Figure 3, 2C) for the relationships between E-number and embedded distance (eye in CDO), and for band width (banding eye).

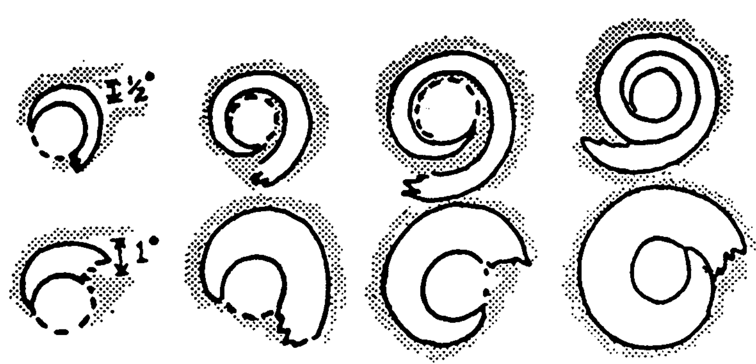
EYE TEMPERATURE

SURR. RING TEMP.	WMG	OW	DG	MG	LG	B	W
OW	0	-0.5					
DG	0	0	-0.5				
MG	0	0	-0.5	-0.5			
LG	+0.5	0	0	-0.5	-0.5		
B	+1.0	+0.5	0	0	-0.5	-0.5	
W	+1.0	+0.5	+0.5	0	0	-1.0	-1.0
CMG	+1.0	+0.5	+0.5	0	0	-0.5	-1.0

Figure 6. Eye Adjustment Graph. Rules: (1) For large or elongated eyes, use values to the right of the diagonal line only; (2) for elongated eye patterns >4.5, subtract .5 when no other subtraction was made.

a. Add 1/2 no. b. Add 1/2 no. c. Add 1 no.

Figure 7. EIR Banding Feaatures. Add to the CF only when the data T-no. is lower than the MET.



BF = 1/2 BF = 1 BF = 1 1/2 BF = 2

Figure 8. VIS Banding Features.

b. The eye adjustment factor is determined by the definition, shape, and size of the eye. The eye is well-defined by either its blackness or by a well-defined boundary. To be well-defined, the eye should be dark or black. Remember that a very high or very low sun angle may reduce the eye definition unrealistically, and that high-resolution pictures may show a poorly defined eye that would not appear in the low-resolution pictures for which the technique was designed. A poorly defined eye is one that is barely visible. A ragged eye is one with a very uneven boundary with little circularity. VIS eye adjustment rules are as follows. (1) For poorly defined or ragged eyes, subtract 1/2 number for E numbers of < 4.5 and subtract 1 number when E > 5. When analyzing patterns with poorly defined eyes especially in high-resolution pictures, also check the CDO size. Use the estimate which is most consistent with the MET. (2) For large eyes, limit the maximum T-number to T6 for round, well-defined eye patterns, and to T5 or lower for all other large-eyed patterns. And, (3) the E-number may also be adjusted upward by either .5 or 1.0 when the eye is well-defined, circular and embedded in a very smooth, very dense appearing canopy. The addition is made only when the data T-number is lower than the MET and the storm's past history gives an expected T-number of T-6 or more. The general rule for the eye adjustment factor is: When an adjustment is not clearcut, use the guidance of the MET to make the final decision.

c. The BF adjustment is often an important factor when VIS pictures are used. It is defined as a dense, mostly overcast band that curves quasi-circularly at least 1/4 the distance around the central feature. Bands that curve evenly around an inner BF may also be counted. The amount of the BF term ranges from .5 to 2.5. It depends on the width of the band and the amount the band curves evenly around the central features, as shown in Figure 8. A BF term is not used for pre-hurricane patterns when the curved dense band concept in Step 2A is used. However, it is still needed for CDO patterns and all hurricane patterns when indicated. For banding eye patterns use the central coil (once around the eye) as the CF and add the BF as indicated. This pattern type is rarely used for DT of greater than 4.5.

Step 2D. CDO Patterns (VIS only)

CDO patterns are defined when a dense, solid-looking mass of clouds covers the cloud system center and lies within the curve of the system's comma band. Both its size and the sharpness of its boundary are important to the analysis. A well-defined CDO has an abrupt edge on at least one side of the cloud mass. An irregular CDO appears within the curve of the comma band but has ragged boundaries and uneven texture. Generally, well-defined CDO's that measure about 1° latitude in their narrowest width are associated with tropical storm intensities while those measuring 2° latitude or more are associated with hurricanes. The size-CF number relationship is given in the analysis diagram, Figure 3. Examples of CDO's are shown in Figure 4, Step 6b. For CDO patterns, the analysis equation is CF + BF = DT. Banding features (BF) are usually added to the CF term for CDO patterns. The BF's are described above in 2C,2C.

Step 2E. Embedded Center Patterns (EIR only)

Embedded center patterns are analyzed when the storm has had a previous history of a T3.5 or greater intensity and when the CSC is clearly indicated to be within a cold overcast (OW or colder). Curved cloud lines or bands within the cold overcast as well as the outer curved bands will indicate the location of the CSC within the overcast. A 10° logarithmic spiral can often be fitted to the system's pattern to help locate the CSC in patterns of hurricane intensity. (See Step 2A for fitting spiral.)

The analysis of this pattern is similar to the eye pattern analysis except that no eye adjustment factor is added. Determine the coldest overcast in which the CSC is embedded the required distance. This yields the central feature number (CF). Then add a banding feature (BF) adjustment when indicated. The equation being CF + BF = DT.

STEP 3. CENTRAL COLD COVER (CCC) PATTERN

The CCC pattern is defined when a more or less round, cold overcast mass of clouds covers the storm center or comma head obscuring the expected signs of pattern evolution. The outer curved bands and lines usually weaken with the onset of CCC. When using VIS pictures, substitute the word "dense" for "cold." It is only rarely that the CCC pattern is used with VIS pictures since the CDO or curved lines are usually visible through the thin cirrus clouds. When the CCC persists (see rules in diagram, Step 3), development has been arrested until signs of development or weakening once again appear in the cloud features. Care should be exercised under the following conditions:

(1) Do not confuse a CCC pattern with a very cold comma pattern. A very cold (usually white) pattern is indicated by a very cold (very smooth texture) comma tail and head with some indication of a wedge in between. Curved cirrus lines or boundaries usually appear around the cold pattern and not around the CCC pattern. The very cold pattern for T-numbers of T3 or less warrant an additional 1/2 number in intensity estimate and often indicates rapid growth.

(2) Do not assume weakening in a CCC pattern when the comma tail begins to decrease in size. It is common to observe the tail decreasing in size at the onset of the CCC. Also the CCC often warms as the eye of the T4 pattern begins to be carved out by a warm incursion into the side of the cold overcast. This signals the resumption of pattern evolution (intensification) even though some warming is evident.

STEP 4. DETERMINE THE TREND OF THE PAST 24-HOUR INTENSITY CHANGE

The trend of the past 24-hour intensity change is determined qualitatively by comparing the cloud features of the current picture with those in the 24-hour old picture of the storm. In general, a disturbance has developed when its center appears better defined with no change in the relation to the dense clouds of the disturbance or is more involved with dense overcast clouds. More precise definitions for development, weakening or steady state changes are given below.

The storm has developed (D):

(1) Curved band pattern: Curved band coils farther around the CSC.

(2) CDO pattern: CDO becomes larger or an increase in banding features is noted.

(3) Shear pattern: CSC becomes more tightly defined in curved cloud lines or appears closer to the dense overcast.

(4) Eye pattern: Eye is more embedded, more distinct (warmer), less ragged, or is surrounded by colder (smoother textured) clouds, or more banding features.

(5) No significant warming (darkening) of the cloud system is noted. By significant, it is meant that a change that is not diurnal (near sunset), which lasts for more than 3 hours, and is great enough to lower the T-number.)

The storm has weakened (W):

(1) The storm has weakened when its cloud pattern indicates a persistent trend opposite to those listed in (1)-(5) above. Watch in particular for patterns that become sheared out (elongated with time) or for patterns undergoing nondiurnal warming (lowering) of their cloud tops.

The storm has become steady state (S):

(1) When a central cold cover appears in a T3.5 or greater storm or has persisted for more than 12 hours in a weaker storm; or

(2) When the CSC's relationship to the cold clouds has not changed significantly; or

(3) When there are conflicting indications of both development and weakening.

STEP 5. THE MODEL EXPECTED T-NUMBER (MET).

The MET is determined by using the 24-hour old T-number, the D, S, or W decision in Step 4, and the past amount of intensity change of the storm. When the growth rate has not been established in the case of new developments or reversals in trend, assume a past rate of change of one T-number per day. Equations for determining the MET are given below.

MET = 24-hour old T-number + (.5 to 1.5) when D was determined.
MET = 24-hour old T-number - (.5 to 1.5) when M was determined.
MET = 24-hour old T-number when S was determined.

Rapid or slow past rates of change are established when two consecutive analyses showing rapid or slow pattern evaluation are observed at 6-hour or more intervals, or when one observation accompanied by signs of strong intensification or weakening is observed (see Step 10).

STEP 6. THE PATTERN T-NUMBER (PT).

The pattern T-number is used primarily as an adjustment to the MET when an adjustment is indicated. The PT-number is determined by choosing the pattern that best matches your storm picture from either the model expected T-number column or the column on either side of it. When the pattern being analyzed looks more like the pattern in the column to the right or left of the MET column, then raise or lower the MET .5 to determine the PT.

STEP 7. RULES FOR DETERMINING THE T-NUMBER

Use the data T-number (DT) when the cloud feature measurements are clear-cut. Use the pattern T-number (PT) when the DT is not clear and the pattern is understandable. When neither the DT or the PT is clear, use the Model Expected T-number (MET).

STEP 8. FINAL T-NUMBER

This step provides the constraints within which the final T-number must fall. In other words, when the T-number gotten from Step 7 does not fall within the stated limits, it must be adjusted to the limits. The constraints hold the final T-number change to 1.5 during the first 24 hours of development; to 2 numbers in 24 hours for T-numbers T2 to T4 (i.e. 1/2 number over a six hour period); and to 2.5 numbers over a 24 hour period for changes in storms of T4 or greater intensity (i.e. 1 number over a six hour period, 1 1/2 numbers in 12 hours, 2 in 18 hours, and 2.5 in 24 hours). In general for storms of hurricane intensity, the final T-number must be within one number of the model expected T-number (MET). The constraints are listed in the diagram. The rules also prohibit the lowering of the T-number at night during the first 48 hours of development because the diurnal changes in clouds often give deceptive indications of weakening at this time.

STEP 9. CURRENT INTENSITY (CI) NUMBER

The CI number relates directly to the intensity of the storm. The empirical relationship between the CI number and the storm's wind speed is shown in figure 9.

CI Number	MWS (Knots)	MSLP (Atlantic)	MSLP (NW Pacific)
1	25 K		
1.5	25 K		
2	30 K	1009 mb	1000 mb
2.5	35 K	1005 mb	997 mb
3	45 K	1000 mb	991 mb
3.5	55 K	994 mb	984 mb
4	65 K	987 mb	976 mb
4.5	77 K	979 mb	966 mb
5	90 K	970 mb	954 mb
5.5	102 K	960 mb	941 mb
6	115 K	948 mb	927 mb
6.5	127 K	935 mb	914 mb
7	140 K	921 mb	898 mb
7.5	155 K	906 mb	879 mb
8	170 K	890 mb	858 mb

Figure 9. The empirical relationship between the current intensity number (CI), the maximum mean wind speed (MWS), and the minimum sea level pressure (MSLP) in tropical cyclones. The MSLP values for the NW Pacific were recommended in Shewchuck and Weir (1980).

After each intensity analysis, the previous analyses of the storm should be reviewed in the light of the current data. When an error was made in the previous day's analysis, correct the T-number to provide a more-accurate model-expected intensity. The correction may at times alter the current intensity analysis.

The CI number is the same as the T-number during the development stages of a tropical cyclone but is held higher than the T-number while a cyclone is weakening. This is done because a lag is observed between the time a storm pattern indicates weakening has begun and the time when the storm's intensity decreases. In practice, the CI number is not lowered until the T-number has shown weakening for 12 hours or more. The CI number is then held one higher than the T-number as the storm weakens. (Hold the CI number 1/2 number higher when the T-number shows a 24 hour decrease of 1/2 number.) When redevelopment occurs, the CI number is not lowered even if the T-number is lower than the CI number. In this case, let the CI number remain the same until the T-number increases to the value of the CI number.

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